REMARKS

In order to expedite the prosecution of the present application, Claims 6, 9 and 10-13 have been canceled. Claim 1 has been amended in order to more particularly point out and distinctly claim the subject matter which Applicants regard as the invention. No new matter has been added.

Claims 6, 9 and 10 have been rejected under 35 USC 102(b) as being anticipated by JP 2001-026831A. The cancellation of these claims have overcome this ground of rejection. Claims 1-4 have been rejected under 35 USC 103(a) as being unpatentable over Sircar. Claims 6-10 have been rejected under 35 USC 103(a) as being unpatentable over JP 04-285139A. Claims 1-3, 8 and 11-13 have been rejected under 35 USC 103(a) as being unpatentable over JP 2001-026831A. Claim 4 has been rejected under 35 USC 103(a) as being unpatentable over JP '831 in view of Iwai et al. Applicants respectfully traverse these grounds of rejection and urge reconsideration in light of the following comments.

The presently claimed invention is directed to an aluminum alloy piping material for automotive tubes which has excellent corrosion resistance and formability and which is an annealed material of an aluminum alloy comprising, in mass %, 0.8 to 1.5% manganese, up to 0.05% copper, 0.10 to 0.20% titanium, 0.30 to 0.60% iron, and up to 0.50% silicon with the balance being aluminum and unavoidable impurities. The aluminum alloy piping material has an average crystal grain size of up to 100 microns and titanium-based compounds having a grain size of 10 microns or more do not exist as an aggregate of two or more serial compounds in a single crystal grain. The aluminum alloy is hot-extruded and cold-drawn at a reduction rate of 30% or more, the total reduction ratio of hot extrusion and cold drawing is 99% or more and the temperature increase rate during annealing is 200°C per hour or more.

The aluminum alloy piping material of the present invention can be used as an automotive tube for connecting an

automotive radiator and heater or as a tube which connects an evaporator, condenser and compressor. Conventionally, tubes used in connecting a radiator and heater for an automotive evaporator, condenser and compressor are expanded at the tube end by bulge forming and have a rubber hose provided on the end thereof which is secured by a metal band. Piping materials made of an aluminum-manganese alloy tend to pit or have inner granular corrosion when used under extreme conditions. When a rubber hose is provided on an end surface thereof, crevice corrosion tends to occur on the underside of the rubber hose on the outer surface of the piping material. Although clad piping can be used to overcome this problem, this results in a significant increase and expense.

In the present invention, it is critical that the aluminum alloy material be formed under specific conditions in order for the material to have an average crystal grain size of 100 microns or less and titanium-based compounds having a grain size of 10 microns or more not to exist as an aggregate of two or more serial compounds in a single crystal grain. If the average grain size exceeds 100 microns, elongation and deformation of the piping material becomes uneven at the time of expansion work, which makes the material susceptible to developing an orange peel surface or cracks. Additionally, even if the average grain size is not greater than 100 microns, if titanium-based compounds having a grain size of 10 microns or more exist as an aggregate of two or more serial compounds in a single alloy crystal grain, stress concentrates during the expansion work and cracks occur from the titanium-based compound. In the instant invention, during the manufacture of the aluminum alloy piping, it is required that the reduction ratio of cold drawing is at least 30% and the total reduction ratio of hot extrusion and cold drawing be at least 99% and the temperature increase rate during annealing be at least 200°C per hour.

If the reduction ratio of cold working is less than 30%, the crystal grain size after annealing will become coarse and

allow the titanium-based compounds to exist as an aggregate of two or more serial compounds in a single crystal grain. This makes the material prone to develop cracks at the time of expansion work. If the total reduction ratio of hot extrusion and cold drawing is less than 99%, the titanium-based compounds formed during casting would not be adequately dispersed and tend to exist at one location so that cracks develop at the time of expansion work.

Also, the smaller the temperature increase rate applied during annealing, the larger the crystal grain size after annealing which allows the titanium-based compounds to exist as an aggregate of two or more serial compounds in a single grain. This makes the material prone to cracking at the time of expansion work. It is respectfully submitted that the currently claimed invention clearly is patentably distinguishable over the prior art cited by the Examiner.

As stated by the Examiner, the Sircar reference discloses an aluminum-based alloy composition consisting essentially of, in weight percent, not more than about 0.03% copper, about 0.1 and up to about 1.5% manganese, about 0.03 to 0.35% titanium, up to 1.0% magnesium, less than 0.01% nickel, between about 0.06 and about 1.0% zinc, up to 0.3% zirconium, amounts of iron and silicon up to about 0.5%, up to 0.20% chromium and the balance being aluminum and inevitable impurities. As also pointed out by the Examiner, this reference teaches that the alloy can be extruded into a tube but does not discuss the average grain size or the degree the titanium-based compounds are aggregated. As such, the Examiner posits that Sircar presents a showing of prima facie obviousness under 35 USC 103(a) with respect to the presently claimed invention.

Although the Sircar reference does have a generic disclosure of an alloy composition which could possibly overlap the alloy composition of the present invention, the alloy of Sircar does not have the structure of the presently claimed invention. That is, in Sircar, the ingot having a thickness of 76.2 mm is hot rolled to a thickness of 9.5 mm,

thereby undergoing a reduction of 87.5%, and cold rolled to a thickness of 1 mm which results in total reduction ratio of 98.7%. The presently claimed invention requires a total reduction ratio of at least 99% and a temperature increasing rate of at least 200°C per hour in order to achieve an alloy having the distribution of titanium-based compounds as is required in the claimed structure of the present invention. In order to establish the criticality of the claimed structure, Applicants are enclosing herewith a Declaration Under 37 CFR 1.132 in which billets are formed from the same aluminum alloy and the billets worked according to the disclosure of Sircar et al and that of the present invention. That is, as shown in Table 1, the total reduction rate of 98.7% of Sircar et al was performed for the Comparative Example while a total reduction rate of 99.3% was performed according to the present invention. After annealing by following the procedures used in the Examples of the present invention and Sircar et al, the average grain size at the outer circumferential surface of the specimens and the distribution pattern of titanium-based compounds were measured and the bulge formability and corrosion resistance were measured.

As explained in a discussion of results in the Declaration Under 37 CFR 1.132, the difference between the aluminum alloys of the present invention and the aluminum alloys of Sircar et al result from the difference in processing. In the present invention, the reduction ratio of cold drawing is at least 30%, the total reduction ratio is at least 99% and the temperature increase rate in annealing is at least 200°C per hour. In Sircar et al, the reduction ratio of cold drawing is 89.5% and the total reduction rate is 98.7% with the temperature increase rate during annealing not being disclosed. As shown by Table 2 contained in the Declaration, the titanium-based compound's distribution number and the alloy prepared according to Sircar et al was 3 and, as such, the bulge formability was inferior as compared with that of

the present invention. As such, the patentability of the presently claimed invention over the Sircar et al reference has been established.

JP '831 discloses an extruded tube containing 0.25 to 0.70% iron, 0.03 to 0.15% copper and 0.05 to 0.45% manganese with the balance being aluminum. The currently presented claims are patentably distinguishable thereover in that Claim 1 now requires that the minimum manganese content at least be 0.8%. Therefore, it is respectfully submitted that the currently presented claims are clearly patentably distinguishable over JP '831.

Claims 1, 7 and 8 are patentably distinguishable over JP '139 in that JP '139 requires that copper be present in an amount of 0.10 to 0.60%. Currently presented Claim 1, and the claims dependent thereon, limit the copper content to no more than 0.05%. Therefore, these claims are patentably distinguishable over JP '139.

Iwai et al has been combined with JP '831 to reject Claim 4. However, as explained above, the manganese content in the currently presented claims is at least 0.8% while JP '831 has an upper limit of manganese content of 0.45%. There is no disclosure in Iwai et al which would motivate one of ordinary skill in the art to modify the manganese content of JP '831 and, therefore, it is respectfully submitted that the presently claimed invention is patentably distinguishable over JP '831 in combination with Iwai et al.

In light of the arguments advanced above, it is respectfully submitted that the currently claimed invention clearly is patentably distinguishable over the prior art cited by the Examiner. The Examiner is respectfully requested to reconsider the present application and to pass it to issue.

Respectfully submitted,

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